ARCHAEOLOGICAL SERVICES WYAS

Land west of Walden Road
Great Chesterford
Essex

Geophysical Survey

Report no. 2560

January 2014

Client: CgMs Consulting

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Great Chesterford
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Summary

A geophysical (magnetometer) survey, covering 9.8 hectares, was carried out on land west of Walden Road, Great Chesterford in advance of the determination of a planning application for a proposed residential development. The site lies to the immediate north-east of Chesterford Roman fort. Anomalies caused by soil-filled archaeological ditches forming enclosures and major landscape boundaries have been identified across the site confirming that the site lies within a landscape of high archaeological potential. The features are presumed to be indicative of activity dating from the Iron Age and Roman periods. Therefore, on the basis of the geophysical survey, the archaeological potential within the west of the site is assessed as being high, with a moderate to high potential in the east.

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Report Information

Client:	CgMs Consulting
Address:	Units 20-22 Newark Beacon, Beacon Hill Office Park, Cafferata Way, Newark, Nottinghamshire, NG24 2TN
Report Type:	Geophysical Survey
Location:	Great Chesterford
County:	Essex
Grid Reference:	TL 508 434
Period(s) of activity: represented	Romano-British
Report Number:	2560
Project Number:	4168
Site Code:	GCE13
OASIS ID	archaeol11-168274
Planning Application No.:	
Date of fieldwork:	December 2013
Date of report:	January 2014
Project Management:	Sam Harrison BSc MSc MIfA
Fieldwork:	Christopher Sykes BA MSc
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Illustrations:	David Harrison
Photography:	Site Staff

Authorisation for distribution: --

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1 Introduction

Archaeological Services WYAS (ASWYAS) were commissioned by Myk Flitcroft of CgMs Consulting, to undertake a geophysical (magnetometer) survey of land at Great Chesterford to enhance the current evidence base in connection with promotion of the site for future residential development. The survey work was undertaken in accordance with a Project Design (Harrison 2013) supplied to and approved by the client, with guidance contained within the National Planning Policy Framework (2012) and in line with current best practice (David *et al.* 2008). The survey was carried out between December 16th and December 19th 2013 in order to provide additional information on the archaeological potential of the site.

Site location, land-use and topography

The proposed development area (PDA) is situated on the northern periphery of the village of Great Chesterford, Essex, centred at TL 508 434 (see Fig. 1). It is bound to the east by the B184 Walden Road, to the west by the B1383 Newmarket Road and a community centre, by a residential estate to the south and by arable farmland to the north. The site comprises of two fields (Field 1 and Field 2) which were under a young cereal crop at the time of survey (see plates) and covered a total of 9.8 hectares. A scheduled monument (see below) extends into the western part of Field 1. No geophysical survey was undertaken within the scheduled zone. The topography slopes slightly from the north-east being at 44m above Ordnance Datum (aOD) at Walden Road and at 38m aOD at Newmarket Road.

Geology and soils

The underlying bedrock comprises New Pit Chalk Formation. No superficial deposits are recorded within the PDA although river terrace deposits (sand and gravel) are recorded to the immediate west of the site (British Geological Survey 2013) – the River Cam runs approximately 400m to the west of the PDA. The soils in this area are classified in the Swaffham Prior and Moulton associations, characterised as well-drained calcareous loams over chalk (Soil Survey of England and Wales 1983).

2 Archaeological Background

The PDA lies within a rich archaeological landscape lying a short distance to the north-east of Great Chesterford walled Roman town and immediately adjacent to the preceding 1st century Roman fort (see Fig. 2). The Roman fort is one of only four examples recorded within Essex (English Heritage 2014) and is thought to be enclosed by a single ditch which survives as a buried feature. An earthen rampart, which was originally constructed on the inside of the ditch, is thought to have been pushed back into the ditch, deliberately back-filling it, in the second half of the 1st century AD. The EH list entry also records an annexe on the north part of the east side of the fort. Both the Roman town and the fort are protected as a Scheduled Monument (Mon. Ref.1013484).

Also included within this designation are two cemeteries of Roman date and an Anglo Saxon cemetery. Numerous heritage assets are recorded in the Essex Sites and Monuments Record (SMR) in the immediate environs of the scheduled area including the site of Roman burials (SMR. Ref. 13916) identified in 1972 during excavations for a new bowling green which lies to the immediate south of the PDA (see Fig. 2). The site of a Romano-Celtic temple (Scheduled Monument Ref. 1017453) is recorded 420m to the east of the PDA. Therefore, on the basis of the current evidence base, the application area is considered to have a high archaeological potential.

3 Aims, Methodology and Presentation

The main aim of the geophysical survey was to provide an appropriate level of evidence on the presence and extent of archaeological assets to inform the current promotion of the site for residential development and support representations being made to the Local Planning Authority. To achieve this aim a magnetometer survey covering the whole of the PDA was carried out, a total of 9.8 hectares.

The general objectives of the geophysical survey were:

- to provide information about the nature and possible interpretation of any magnetic anomalies identified;
- to therefore determine the presence/absence and extent of any buried archaeological features; and
- to prepare a report summarising the results of the survey.

Magnetometer survey

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). Bartington Grad601 magnetic gradiometers were used during the survey taking readings at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m grids so that 3600 readings were recorded in each grid. These readings were stored in the memory of the instrument and later downloaded to computer for processing and interpretation. Geoplot 3 (Geoscan Research) software was used to process and present the data. Further details are given in Appendix 1.

Reporting

A general site location plan, incorporating the Ordnance Survey map, is shown in Figure 1 at a scale of 1:50000. Figure 2 is a large scale (1:4000) survey location plan showing the processed greyscale magnetometer data and the scheduled monument areas. Figure 3 shows an overall interpretation of the magnetometer data at a scale of 1:2000. Detailed data plots (‘raw’ and processed) and full interpretative figures are presented at a scale of 1:1000 in Figures 4 to 12 inclusive.

Further technical information on the equipment used, data processing and survey methodologies are given in Appendix 1 and Appendix 2. Appendix 3 describes the composition and location of the site archive.

The geophysical survey methodology, report and any recommendations comply with guidelines outlined by English Heritage (David *et al.* 2008) and by the Institute for Archaeologists (IfA 2013). All figures reproduced from Ordnance Survey mapping are with the permission of the controller of Her Majesty’s Stationery Office (© Crown copyright).

The figures in this report have been produced following analysis of the data in ‘raw’ and processed formats and over a range of different display levels. All figures are presented to most suitably display and interpret the data from this site based on the experience and knowledge of Archaeological Services staff.

4 Results and Discussion (see Figs 4 to 12 inclusive)

The anomalies identified by the survey fall into a number of different types and categories according to their origin and these are discussed below and cross-referenced to specific examples within the interpretative figures.

Ferrous Anomalies

Ferrous responses, manifesting either as individual ‘spike’ anomalies or more extensive areas of magnetic disturbance, are typically caused by modern ferrous (magnetic) debris, either on the ground surface or in the plough-soil, or are due to the proximity of magnetic material in field boundaries, buildings or other above ground features. Little importance is normally given to such anomalies, unless there is any supporting evidence for an archaeological interpretation. Ferrous debris or material is common on rural sites, often being present as a consequence of manuring or tipping/infilling. Throughout the site iron ‘spike’ anomalies are common and there is no obvious pattern or clustering to their distribution to suggest anything other than a random background scatter of ferrous debris in the plough-soil.

High magnitude ‘spike’ anomalies **A**, **B**, **D** and **E** are due to telegraph poles at these locations. A cluster of ferrous anomalies coalescing into a broader area of magnetic disturbance, **C**, is caused by ground disturbance and iron support cables associated with the adjacent telegraph pole, **B**.

Areas of magnetic disturbance identified at the perimeters of the survey area are caused by ferrous material within the adjacent boundaries, roads, and buildings. Disturbance of this nature may mask or obscure any anomalies of archaeological potential, if present, within the affected area.

Agricultural Anomalies

Over the last 150 years the size of the fields within the PDA has been increased by the removal of a north-south aligned boundary and north-east/south-west aligned footpath/trackway from within Field 1. These former features are depicted on the first edition Ordnance Survey map (1877) but have not been detected by the magnetometer survey, although the route of the former footpath/trackway is marked by the line of the telegraph poles **B**, **D**, and **E**. The location of the former boundary corresponds closely to the interface between variable magnetic background, to the west of **B**, and the more homogenous background visible to the east. This difference in background response may indicate differing land use (e.g. manuring or deeper ploughing methods) either side of the former boundary, now removed. It is unclear whether the absence of these features within the magnetometer data is the result of low magnetic contrast between cut features (e.g. ditches) and the prevailing soils and superficial deposits or whether all trace of them has been subsequently removed by the plough.

A series of faint parallel linear trend anomalies have been identified within the north of Field 1. The close spacing between these anomalies, and their orientation parallel with existing field boundaries, is typical of modern ploughing.

Geological Anomalies

As discussed above, a clear contrast in background magnetic variation is visible across Field 1 with a denser scattering of discrete anomalies (areas of magnetic enhancement) being identified to the west of telegraph pole **B**. These anomalies may be due the differing depth and composition of the topsoil resulting from modern agricultural practices, such as manuring, and constrained by the former north-west/south-east aligned boundary (now removed). However, it is also noted that river terrace deposits (sands and gravels) are recorded to the immediate west of the PDA and it is possible that some, or all of these anomalies correspond to these superficial deposits, perhaps re-deposited by the plough. In contrast, the magnetic background is less variable within the north-eastern half of the site. However, chalk bedrock is particularly susceptible to erosion by agencies such as water and ice and this erosion manifests in the data as a series of short, sinuous linear anomalies, **F**, within the north of the PDA. These anomalies are thought to be caused by an accumulation of magnetically enhanced material within fissures in the bedrock. Broader, amorphous anomalies, **G**, within the east of Field 2 are more typical of areas of silting, perhaps resulting from episodes of seasonal waterlogging associated with the adjacent watercourse, a tributary of the River Cam, to the south of the field.

Archaeological and Possible Archaeological Anomalies

Unless otherwise stated, linear anomalies of archaeological origin are thought to be caused by infilled cut features such as ditches, whilst more amorphous anomalies of increased magnitude are interpreted as soil-filled pits, gullies or spreads of burnt material.

The eastern half of the PDA is dominated by two clear linear anomalies, **H** and **I**. Anomaly **H**, aligned north-south, extends from the south of the PDA in Field 2 for 315m across the full width of the survey area before continuing beyond the PDA to the north of Field 1. Aerial photographs viewed on Google earth show this feature extending at least a further 700m northwards. This is thought to indicate an Iron Age or Roman boundary ditch. Intersecting obliquely with this presumed boundary feature, within the east of Field 1, is a second slightly sinuous anomaly, **I**. This feature extends for 530m from Walden Road in a north-easterly orientation towards the westernmost corner in Field 1, north of the Roman fort. Here, four rectangular ditched enclosures **E1** - **E4** have been identified appended to the northern side of this boundary feature, **I**. The highly variable magnetic background in this part of the site makes the confident interpretation of any discrete features within these enclosures impossible although it is considered highly likely that some of the discrete anomalies, interpreted as geological, will have some archaeological potential. A possible internal division, **J**, has been identified within enclosure **E1**, visible as a fragmented linear anomaly aligned north-south and probably being due to a soil-filled ditch. This enclosure is separated from the others by a possible trackway, **TR1**, defined by the western extent of **E1** and the eastern extent of enclosures **E2** and **E4**.

Just outside the north-eastern corner of the Roman fort a rectilinear negative anomaly, **K**, can be seen on the same north-east/south-west alignment as the scheduled monument. This anomaly may be caused by a buried bank or rubble-filled ditch and is thought to indicate the actual footprint of the fort. If so, it is likely that the negative anomaly is due to the back-filled material (perhaps turf and rubble) being less magnetic than the surrounding soils. A broad high-magnitude circular anomaly, **L**, at the apex of this anomaly is particularly interesting given its location at the corner of the fort and may indicate a spread of burnt or demolition material, possibly a kiln or oven.

Tentatively, two outlying areas of archaeological potential have been identified within Field 2. A concentration of discrete anomalies, **M**, is roughly square in appearance and may be archaeological in origin, perhaps indicating a small enclosure. This interpretation is cautious but given further credence by the orientation of the anomalies on a north-south orientation in keeping with the adjacent boundary feature, **H**. A short distance to the north-west, a rectilinear anomaly, **N**, appears to be appended to **H**, and may indicate another small enclosure. However, these anomalies are faint and weakly defined and both could be the result of localised areas of geological variation.

5 Conclusions

The geophysical survey has identified clear areas of archaeological potential across the PDA. At the north-eastern corner of the Roman fort a rectilinear feature, perhaps a bank or rubble-filled ditch, has been identified. It is unclear whether this anomaly indicates the footprint of the fort or the annexe. Definite archaeological activity is identified to the immediate north-east of the fort. Here, four enclosures and a trackway have been identified appended to the northern side of a boundary ditch. The alignment of these enclosures differs slightly to that of the Roman fort raising the possibility that they indicate part of an earlier Iron Age complex. Interpretation of the enclosures is restricted by the survey extents and by complicating geological factors, but the lack of any definite archaeological anomalies within the interiors may suggest an agricultural, rather than settlement use, such as stock enclosures. A second boundary ditch is identified in the eastern half of the PDA on a north-south orientation and is thought to indicate a part of an extensive boundary ditch.

Therefore, based on the geophysical survey, the archaeological potential of the western half of the PDA is considered to be very high, with a moderate to high potential to the east.

Disclaimer

The results and subsequent interpretation of data from geophysical surveys should not be treated as an absolute representation of the underlying archaeological and non-archaeological remains. Confirmation of the presence or absence of archaeological remains can only be achieved by direct investigation of sub-surface deposits.

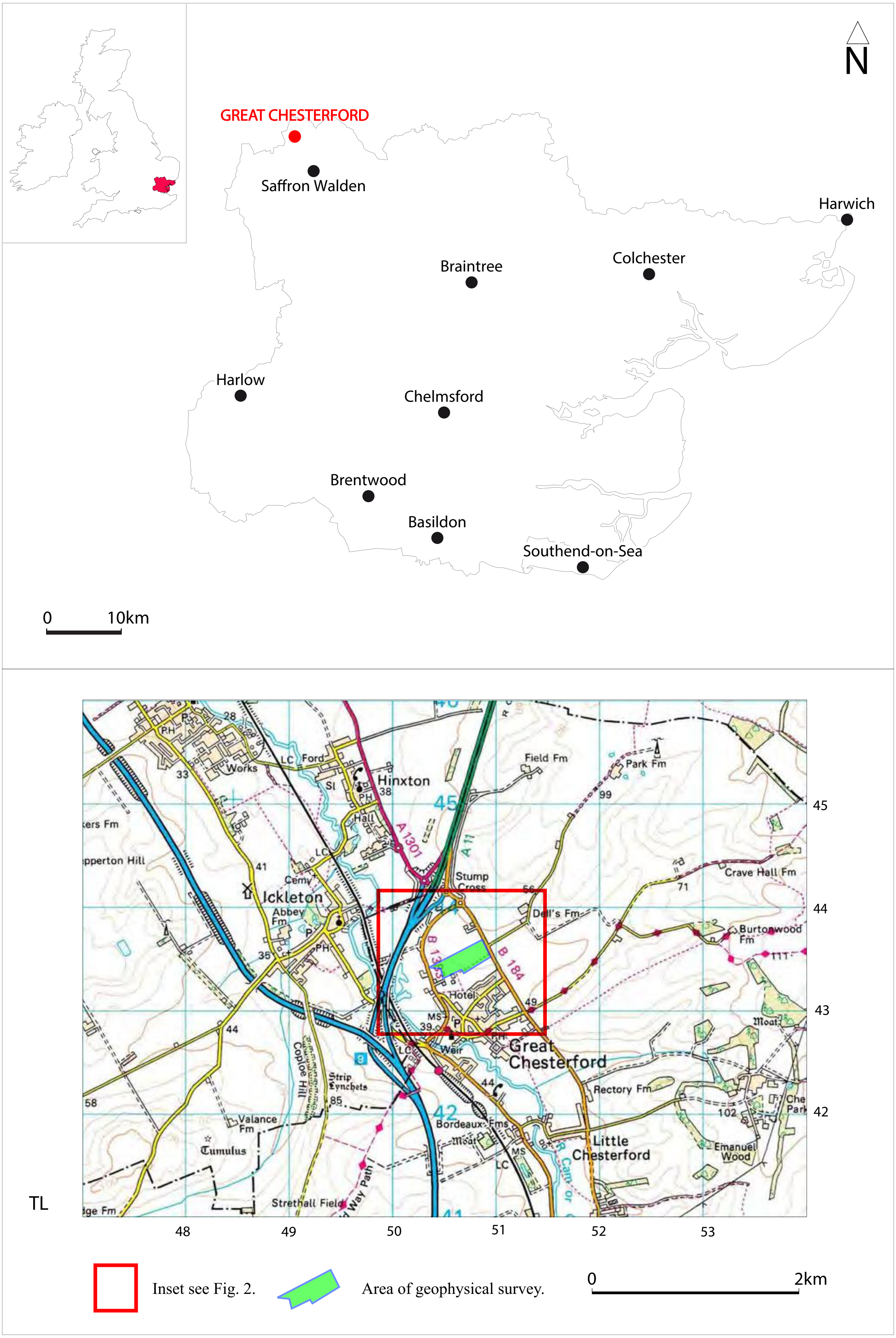


Fig. 1. Site location

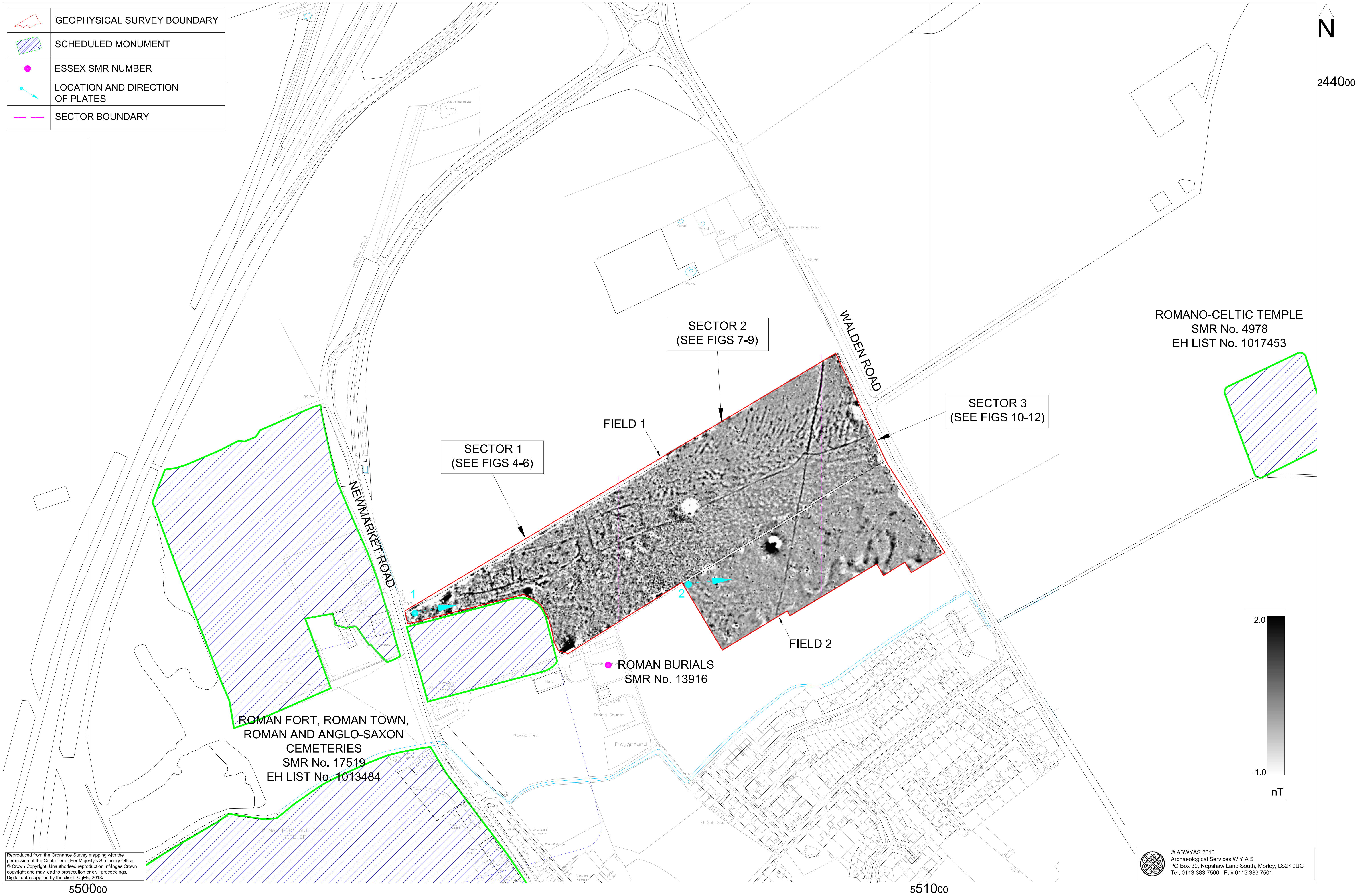
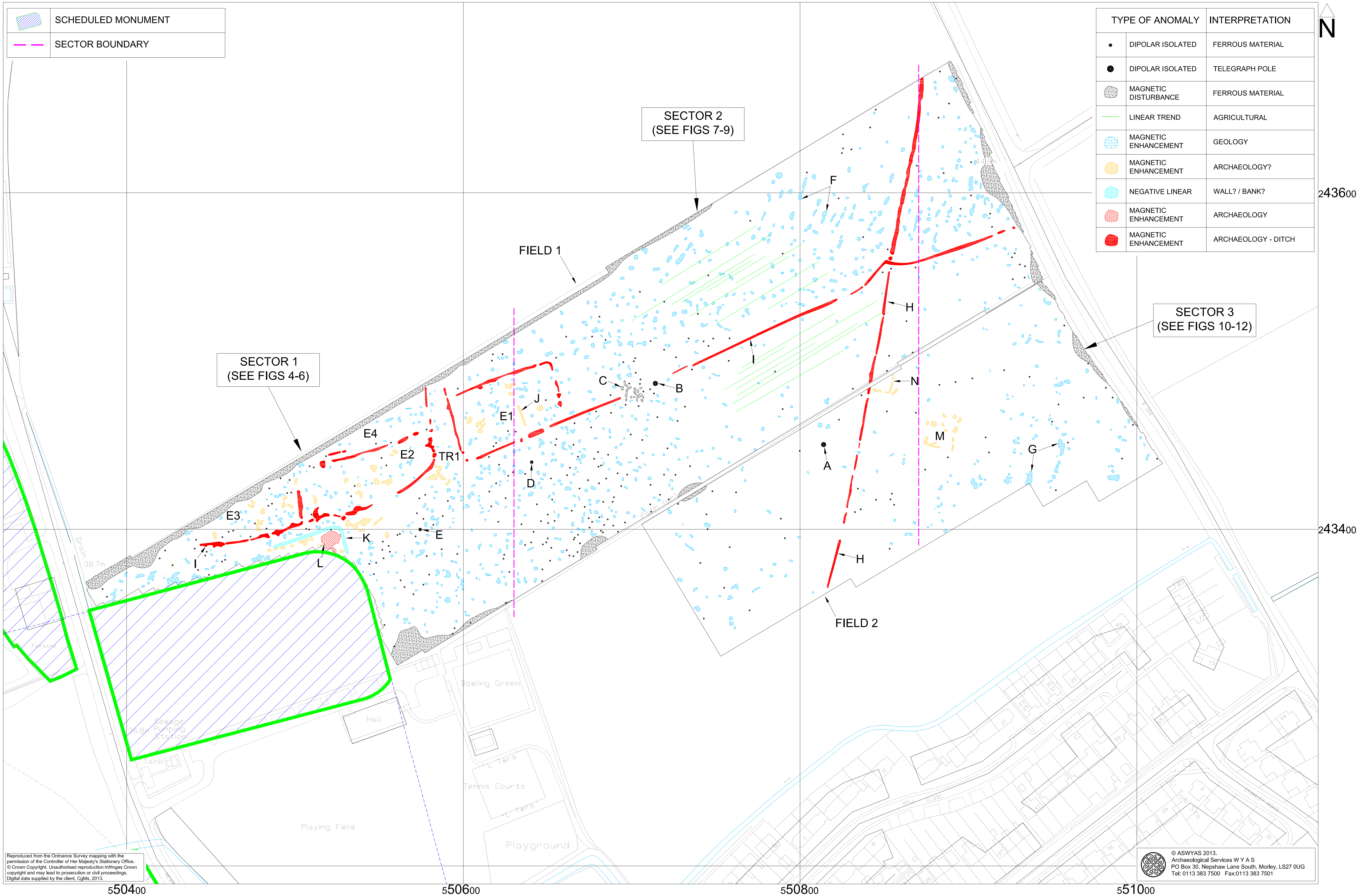


Fig. 2. Survey location showing greyscale magnetometer data and scheduled monument areas (1:4000 @ A3)



0 50m

Fig. 3. Overall interpretation of magnetometer data (1:2000 @ A3)

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Fig. 4. Processed greyscale magnetometer data; Sector 1 (1:1000 @ A3)

Fig. 5. XY trace plot of minimally processed magnetometer data; Sector 1 (1:1000 @ A3)

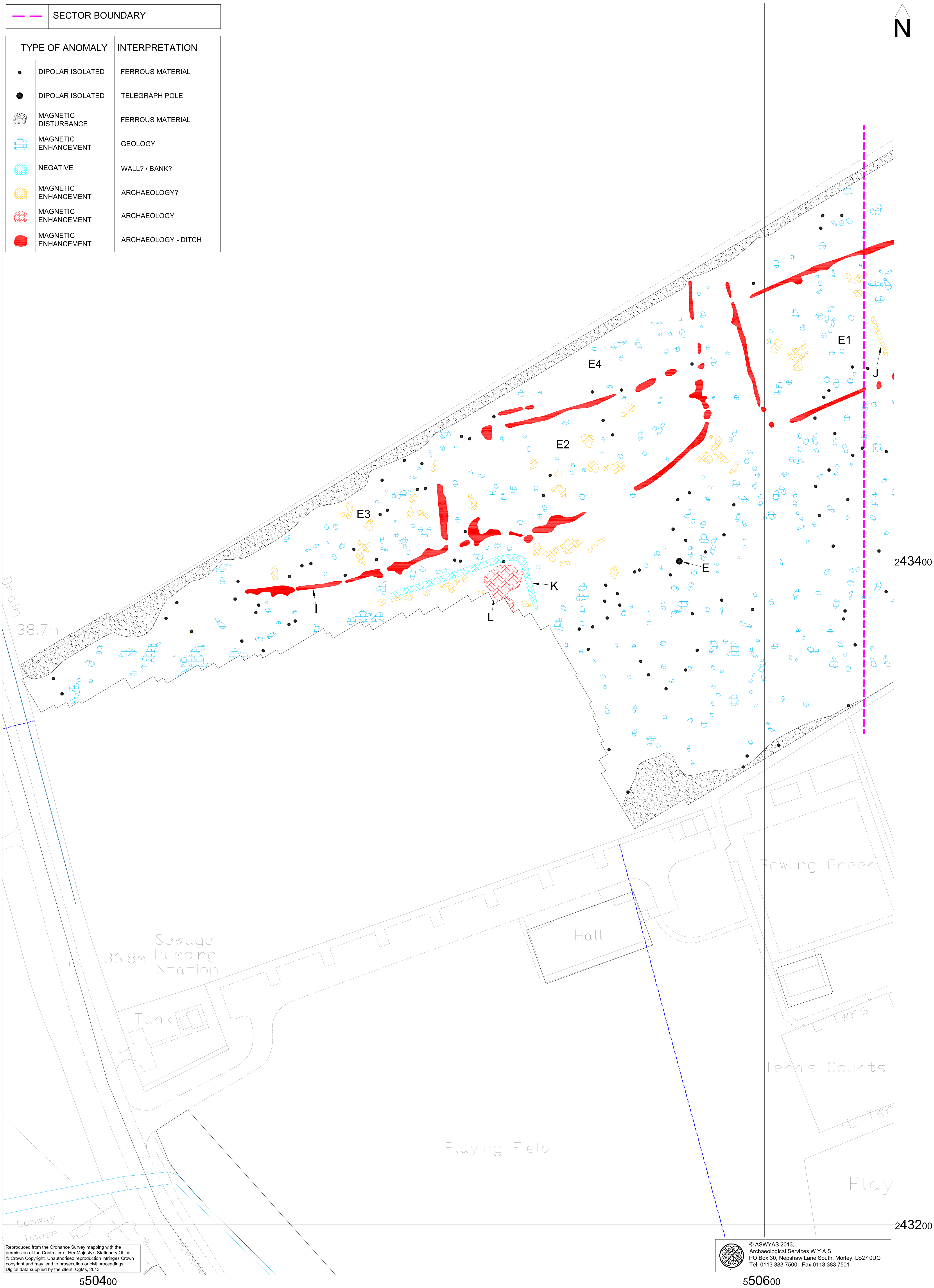

Fig. 6. Interpretation of magnetometer data; Sector 1 (1:1000 @ A3)

0 25m

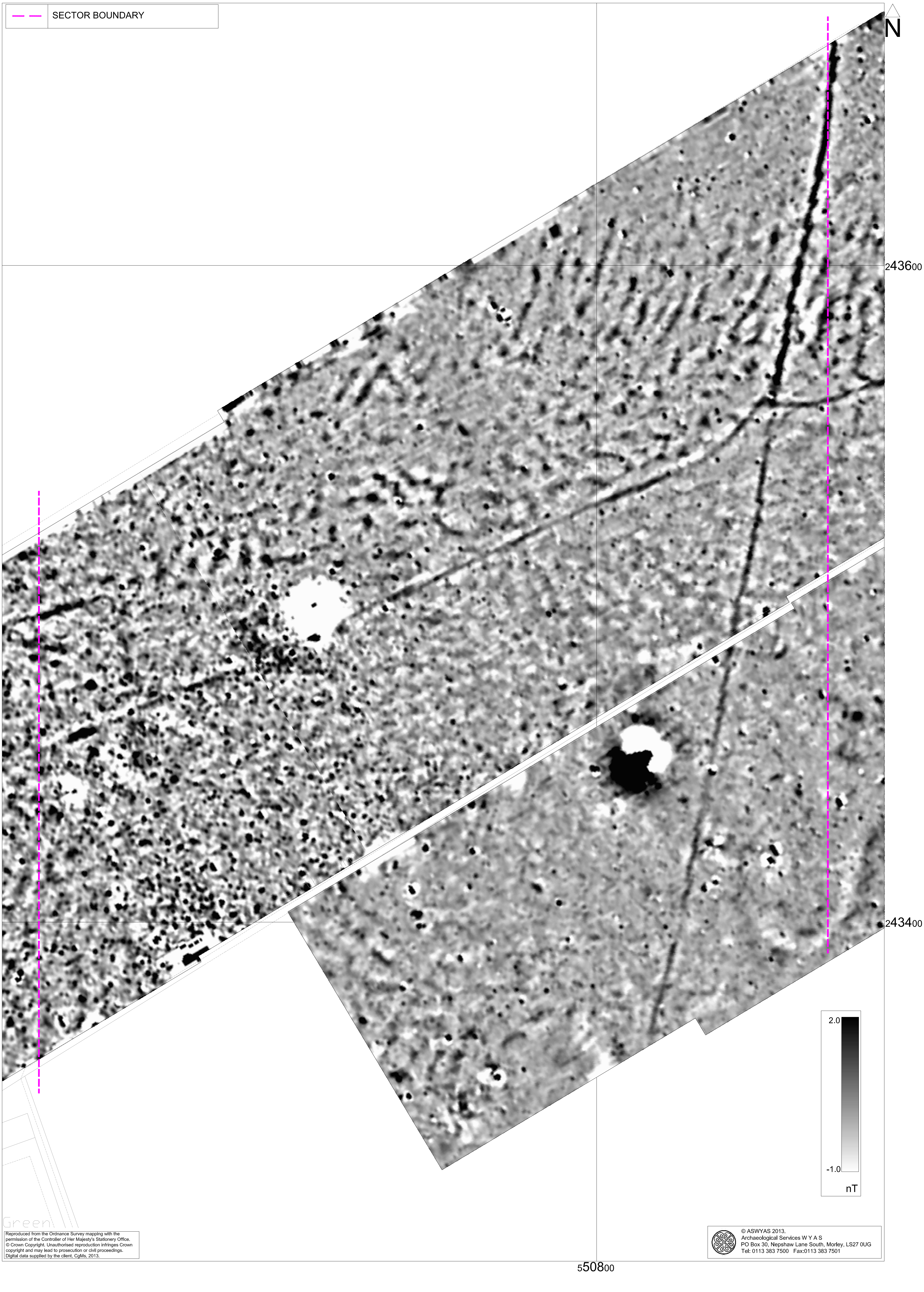

Fig. 7. Processed greyscale magnetometer data; Sector 2 (1:1000 @ A3)

Fig. 8. XY trace plot of minimally processed magnetometer data; Sector 2 (1:1000 @ A3)

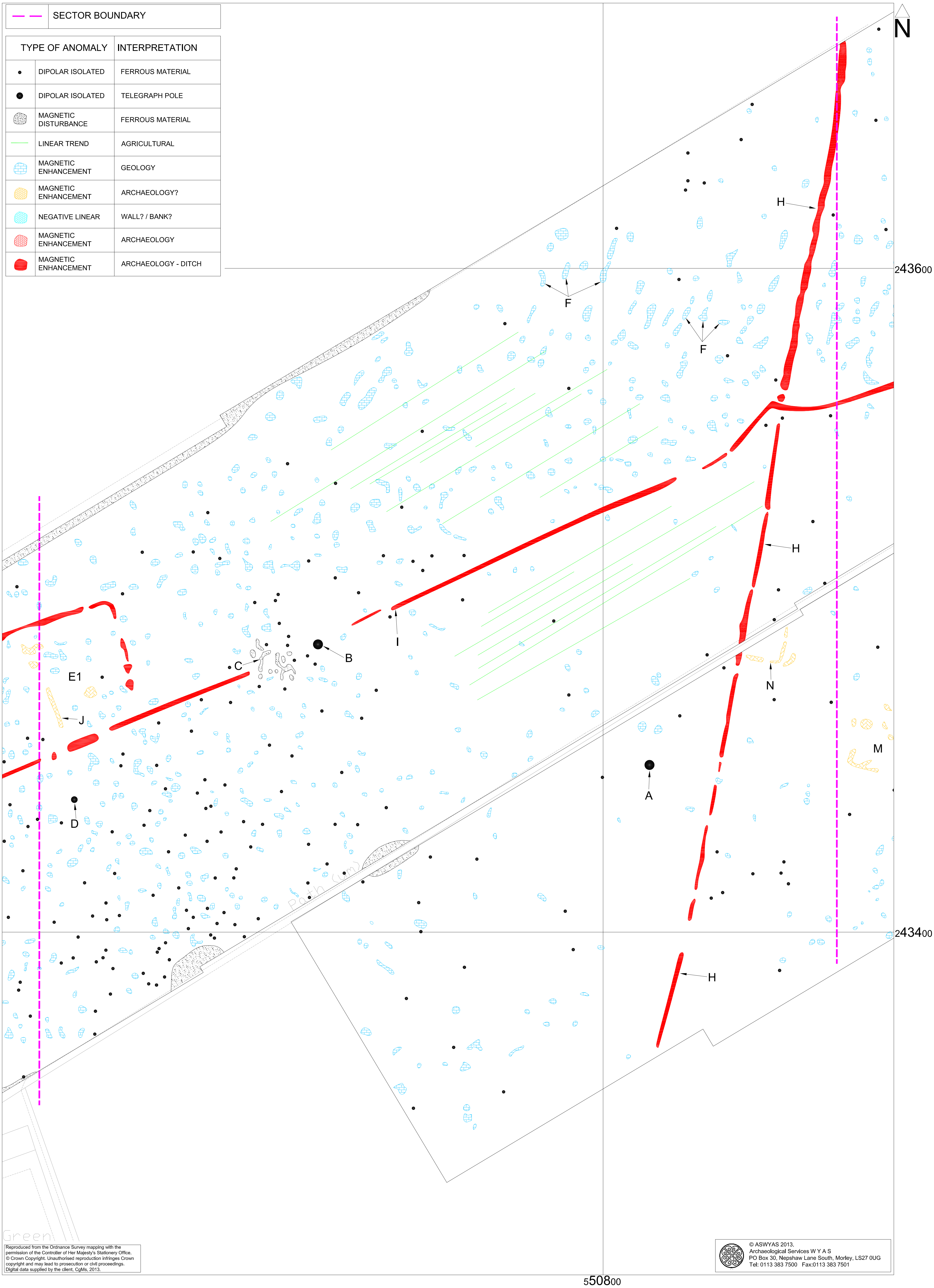

Fig. 9. Interpretation of magnetometer data; Sector 2 (1:1000 @ A3)

0 25m

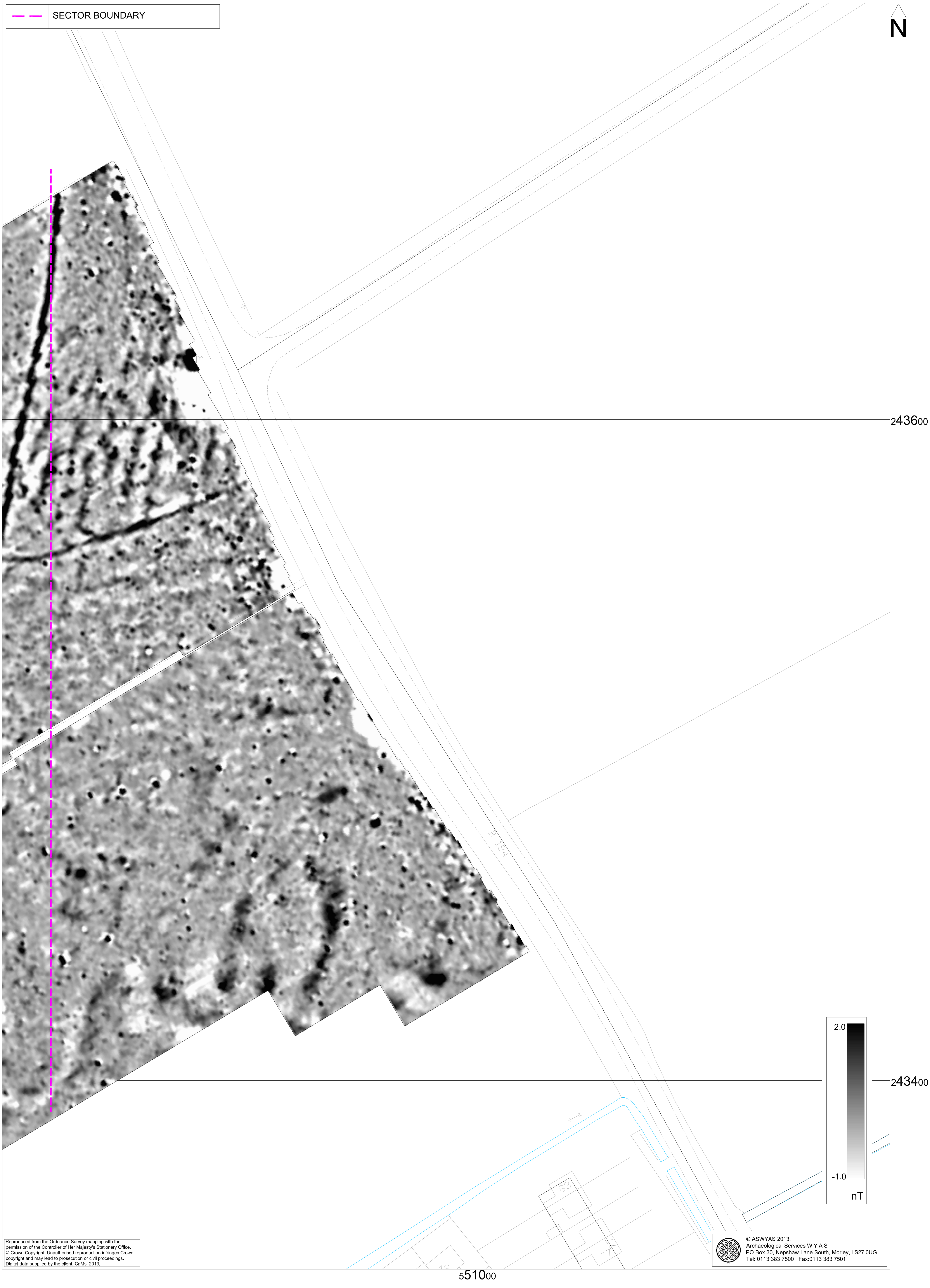

Fig. 10. Processed greyscale magnetometer data; Sector 3 (1:1000 @ A3)

0 25m

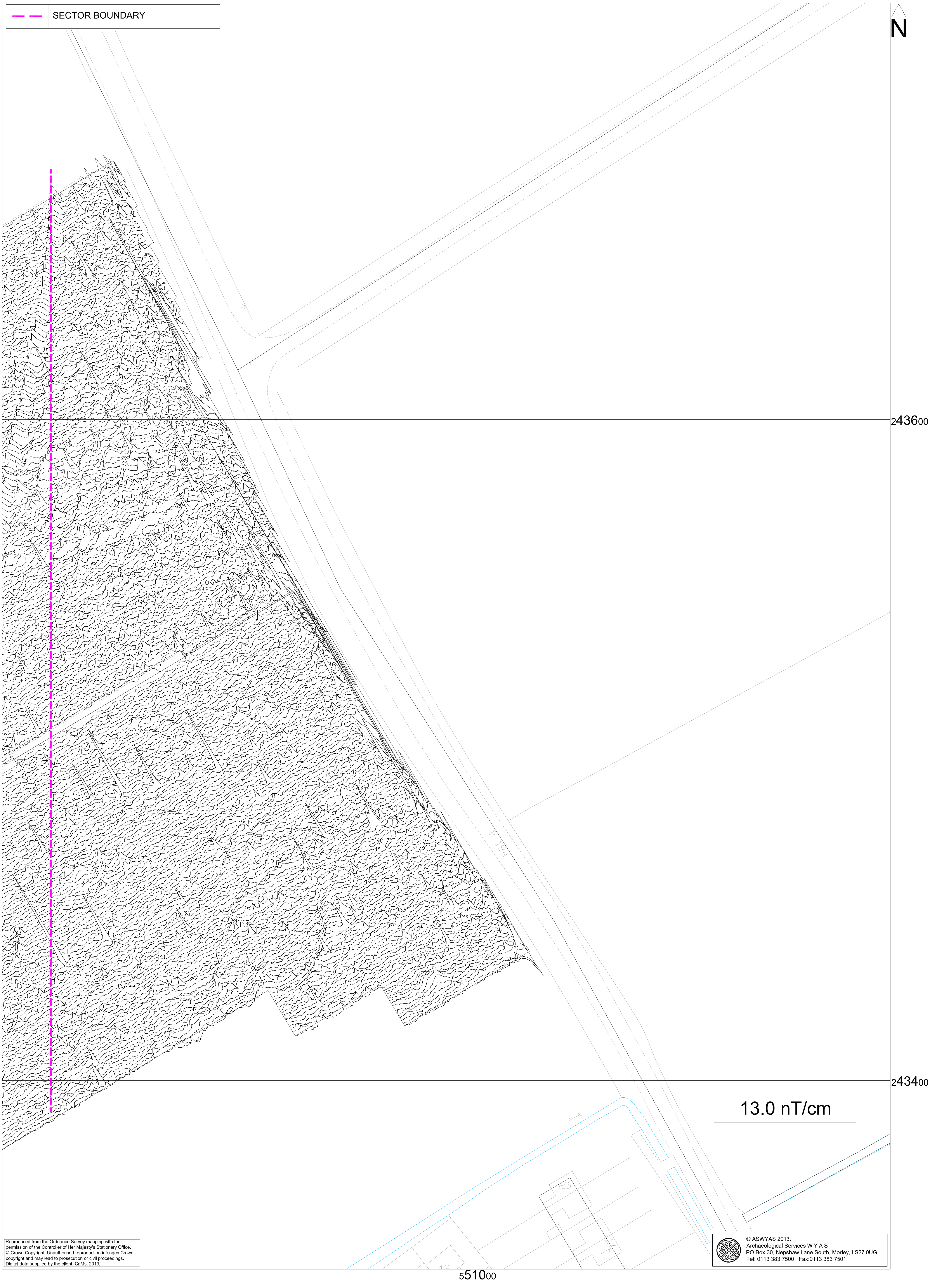

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Fig. 11. XY trace plot of minimally processed magnetometer data; Sector 3 (1:1000 @ A3)

0 25m

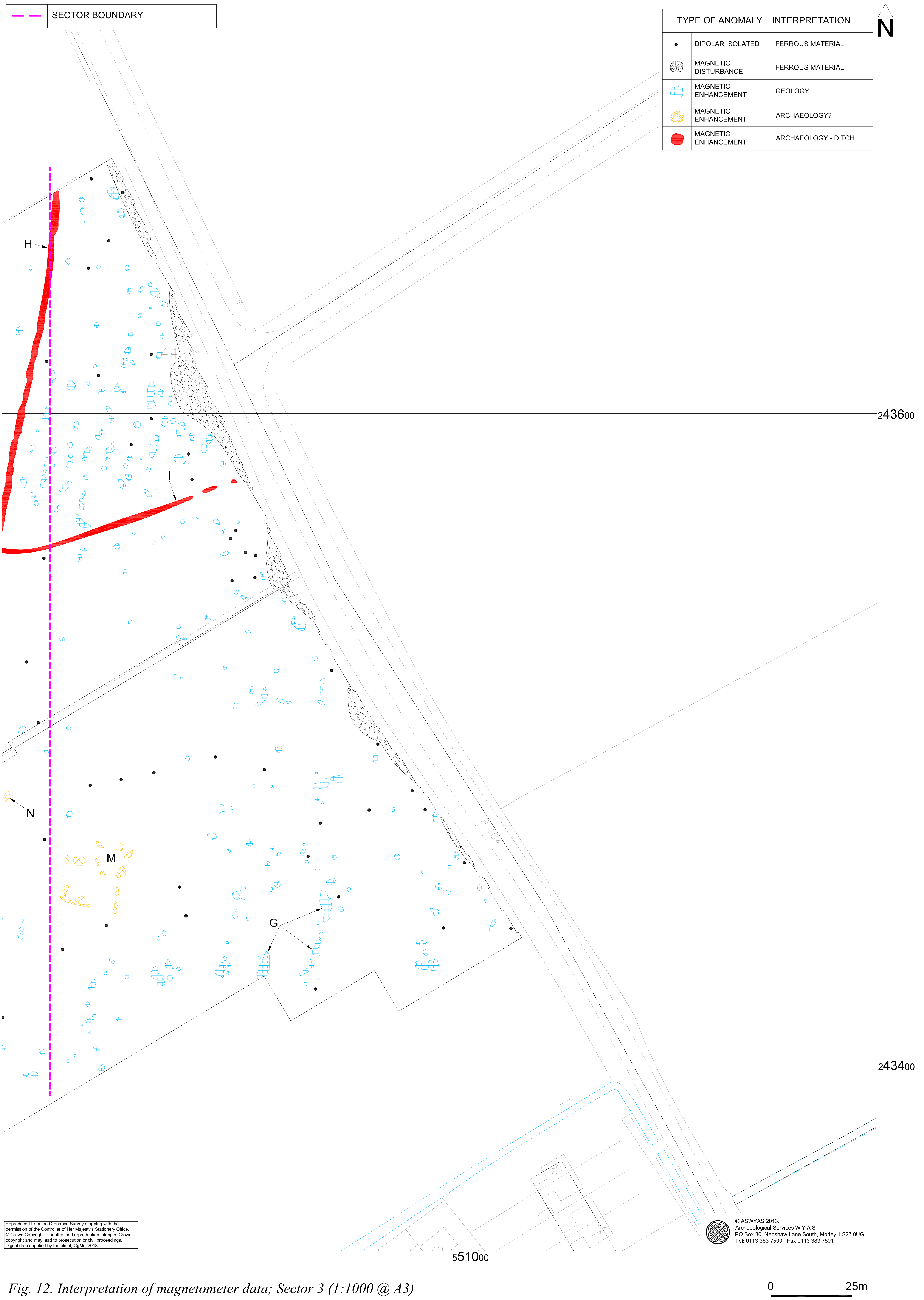

Fig. 12. Interpretation of magnetometer data; Sector 3 (1:1000 @ A3)

Plate 1. General view of Field 1, looking east

Plate 2. General view of Field 2, looking east

Appendix 1: Magnetic survey - technical information

Magnetic Susceptibility and Soil Magnetism

Iron makes up about 6% of the Earth's crust and is mostly present in soils and rocks as minerals such as maghaemite and haemetite. These minerals have a weak, measurable magnetic property termed magnetic susceptibility. Human activities can redistribute these minerals and change (enhance) others into more magnetic forms so that by measuring the magnetic susceptibility of the topsoil, areas where human occupation or settlement has occurred can be identified by virtue of the attendant increase (enhancement) in magnetic susceptibility. If the enhanced material subsequently comes to fill features, such as ditches or pits, localised isolated and linear magnetic anomalies can result whose presence can be detected by a magnetometer (fluxgate gradiometer).

In general, it is the contrast between the magnetic susceptibility of deposits filling cut features, such as ditches or pits, and the magnetic susceptibility of topsoils, subsoils and rocks into which these features have been cut, which causes the most recognisable responses. This is primarily because there is a tendency for magnetic ferrous compounds to become concentrated in the topsoil, thereby making it more magnetic than the subsoil or the bedrock. Linear features cut into the subsoil or geology, such as ditches, that have been silted up or have been backfilled with topsoil will therefore usually produce a positive magnetic response relative to the background soil levels. Discrete feature, such as pits, can also be detected. The magnetic susceptibility of a soil can also be enhanced by the application of heat and the fermentation and bacterial effects associated with rubbish decomposition. The area of enhancement is usually quite large, mainly due to the tendency of discard areas to extend beyond the limit of the occupation site itself, and spreading by the plough. An advantage of magnetic susceptibility over magnetometry is that a certain amount of occupational activity will cause the same proportional change in susceptibility, however weakly magnetic is the soil, and so does not depend on the magnetic contrast between the topsoil and deeper layers. Susceptibility survey is therefore able to detect areas of occupation even in the absence of cut features. On the other hand susceptibility survey is more vulnerable to the masking effects of layers of colluvium and alluvium as the technique, using the Bartington system, can generally only measure variation in the first 0.15m of ploughsoil.

Types of Magnetic Anomaly

In the majority of instances anomalies are termed 'positive'. This means that they have a positive magnetic value relative to the magnetic background on any given site. However some features can manifest themselves as 'negative' anomalies that, conversely, means that the response is negative relative to the mean magnetic background.

Where it is not possible to give a probable cause of an observed anomaly a '?' is appended.

It should be noted that anomalies interpreted as modern in origin might be caused by features that are present in the topsoil or upper layers of the subsoil. Removal of soil to an archaeological or natural layer can therefore remove the feature causing the anomaly.

The types of response mentioned above can be divided into five main categories that are used in the graphical interpretation of the magnetic data:

Isolated dipolar anomalies (iron spikes)

These responses are typically caused by ferrous material either on the surface or in the topsoil. They cause a rapid variation in the magnetic response giving a characteristic 'spiky' trace. Although ferrous archaeological artefacts could produce this type of response, unless there is supporting evidence for an archaeological interpretation, little emphasis is normally given to such anomalies, as modern ferrous objects are common on rural sites, often being present as a consequence of manuring.

Areas of magnetic disturbance

These responses can have several causes often being associated with burnt material, such as slag waste or brick rubble or other strongly magnetised/fired material. Ferrous structures such as pylons, mesh or barbed wire fencing and buried pipes can also cause the same disturbed response. A modern origin is usually assumed unless there is other supporting information.

Linear trend

This is usually a weak or broad linear anomaly of unknown cause or date. These anomalies are often caused by agricultural activity, either ploughing or land drains being a common cause.

Areas of magnetic enhancement/positive isolated anomalies

Areas of enhanced response are characterised by a general increase in the magnetic background over a localised area whilst discrete anomalies are manifest by an increased response (sometimes only visible on an XY trace plot) on two or three successive traverses. In neither instance is there the intense dipolar response characteristic exhibited by an area of magnetic disturbance or of an 'iron spike' anomaly (see above). These anomalies can be caused by infilled discrete archaeological features such as pits or post-holes or by kilns. They can also be caused by pedological variations or by natural infilled features on certain geologies. Ferrous material in the subsoil can also give a similar response. It can often therefore be very difficult to establish an anthropogenic origin without intrusive investigation or other supporting information.

Linear and curvilinear anomalies

Such anomalies have a variety of origins. They may be caused by agricultural practice (recent ploughing trends, earlier ridge and furrow regimes or land drains), natural geomorphological features such as palaeochannels or by infilled archaeological ditches.

Methodology: Magnetic Susceptibility Survey

There are two methods of measuring the magnetic susceptibility of a soil sample. The first involves the measurement of a given volume of soil, which will include any air and moisture that lies within the sample, and is termed volume specific susceptibility. This method results in a bulk value that it not necessarily fully representative of the constituent components of the sample. For field surveys a Bartington MS2 meter with MS2D field loop is used due to its speed and simplicity. The second technique overcomes this potential problem by taking into account both the volume and mass of a sample and is termed mass specific susceptibility. However, mass specific readings cannot be taken in the field where the bulk properties of a soil are usually unknown and so volume specific readings must be taken. Whilst these values are not fully representative they do allow general comparisons across a site and give a broad indication of susceptibility changes. This is usually enough to assess the susceptibility of a site and evaluate whether enhancement has occurred.

Methodology: Gradiometer Survey

There are two main methods of using the fluxgate gradiometer for commercial evaluations. The first of these is referred to as ***magnetic scanning*** and requires the operator to visually identify anomalous responses on the instrument display panel whilst covering the site in widely spaced traverses, typically 10m apart. The instrument logger is not used and there is therefore no data collection. Once anomalous responses are identified they are marked in the field with bamboo canes and approximately located on a base plan. This method is usually employed as a means of selecting areas for detailed survey when only a percentage sample of the whole site is to be subject to detailed survey.

The disadvantages of magnetic scanning are that features that produce weak anomalies (less than 2nT) are unlikely to stand out from the magnetic background and so will be difficult to detect. The coarse sampling interval means that discrete features or linear features that are parallel or broadly oblique to the direction of traverse may not be detected. If linear features are suspected in a site then the traverse direction should be perpendicular (or as close as is possible within the physical constraints of the site) to the orientation of the suspected features. The possible drawbacks mentioned above mean that a 'negative' scanning result should be validated by sample detailed magnetic survey (see below).

The second method is referred to as ***detailed survey*** and employs the use of a sample trigger to automatically take readings at predetermined points, typically at 0.25m intervals, on zig-zag traverses 1m apart. These readings are stored in the memory of the instrument and are later dumped to computer for processing and interpretation. Detailed survey allows the visualisation of weaker anomalies that may not have been detected by magnetic scanning.

During this survey a Bartington Grad601 magnetic gradiometer was used taking readings on the 0.1nT range, at 0.25m intervals on zig-zag traverses 1m apart within 30m by 30m square grids. The instrument was checked for electronic and mechanical drift at a common point and calibrated as necessary. The drift from zero was not logged.

Data Processing and Presentation

The detailed gradiometer data has been presented in this report in XY trace and greyscale formats. In the former format the data shown is 'raw' with no processing other than grid biasing having been done. The data in the greyscale images has been interpolated and selectively filtered to remove the effects of drift in instrument calibration and other artificial data constructs and to maximise the clarity and interpretability of the archaeological anomalies.

An XY plot presents the data logged on each traverse as a single line with each successive traverse incremented on the Y-axis to produce a 'stacked' plot. A hidden line algorithm has been employed to block out lines behind major 'spikes' and the data has been clipped. The main advantage of this display option is that the full range of data can be viewed, dependent on the clip, so that the 'shape' of individual anomalies can be discerned and potentially archaeological anomalies differentiated from 'iron spikes'. Geoplot 3 software was used to create the XY trace plots.

Geoplot 3 software was used to interpolate the data so that 3600 readings were obtained for each 30m by 30m grid. The same program was used to produce the greyscale images. All greyscale plots are displayed using a linear incremental scale.

Appendix 2: Survey location information

The site grid was laid out using a Trimble VRS differential Global Positioning System (Trimble 5800 model). The accuracy of this equipment is better then 0.01m. The survey grids were then super-imposed onto a base map provided by the client to produce the displayed block locations. However, it should be noted that Ordnance Survey positional accuracy for digital map data has an error of 0.5m for urban and floodplain areas, 1.0m for rural areas and 2.5m for mountain and moorland areas. This potential error must be considered if co-ordinates are measured off hard copies of the mapping rather than using the digital co-ordinates.

Archaeological Services WYAS cannot accept responsibility for errors of fact or opinion resulting from data supplied by a third party

Appendix 3: Geophysical Archive

The geophysical archive comprises:-

- an archive disk containing compressed (WinZip 8) files of the raw data, report text (Microsoft Word 2000), and graphics files (Adobe Illustrator CS2 and AutoCAD 2008) files; and
- a full copy of the report.

At present the archive is held by Archaeological Services WYAS although it is anticipated that it may eventually be lodged with the Archaeology Data Service (ADS). Brief details may also be forwarded for inclusion on the English Heritage Geophysical Survey Database after the contents of the report are deemed to be in the public domain (i.e. available for consultation in the Essex Historic Environment Record).

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